

National Climatic Data Center

DATA DOCUMENTATION

FOR

DATASET 3598 (DSI-3598)

Visible Infrared Spin Scan Radiometer
VISSR

February 11, 2004

National Climatic Data Center
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1. Abstract: The Satellite Services Division (SSD) of the National Climatic Data Center (NCDC), in conjunction with the National Environmental Satellite Service (NESS), established a digital tape archive of SMS/GOES VISSR data. VISSR is an acronym for Visible Infrared Spin Scan Radiometer, an instrument flown aboard the SMS/GOES series of geostationary satellites.

Four mile resolution visible and infrared sectors from satellites operating in both East and West positions have been archived. Since September 6, 1978 this archive includes three hourly data from both satellite positions. From August 1976 to that data coverage was limited to five IR sectors and one visible sector per day per satellite. Data from SMS-1, SMS-2, GOES-1, GOES-2, and GOES-3 is included in the archive.

In addition to the VISSR sector, NCDC also maintains a comprehensive archive of SMS/GOES imagery (photographic negatives) including all sectors produced operationally by NESS (Infrared and Visible of various resolutions covering various areas). NCDC has archived over 500,000 negatives, dating back to May 1974 (and a complete archive of Advanced Technology Satellite (ATS) imagery, dating back to February of 1966).

The normal geographic coverage of the Archive Sector will be about 88° latitude by 99° longitude for data prior to November 14, 1977 and 105° latitude by 99° longitude thereafter. This coverage will be reduced when a satellite is operated in limited scan mode, as is the case of storm days when data are collected only as far south as 5° south. Even on normal operating days, some variation in coverage will occur. The directory file will indicate any data missing due to equipment failure or whatever.

The time for which data are available are shown below. Note that these times apply on normal operating days only, and even then may vary by up to an hour.

A. Since September 6, 1978:

West Satellite	East Satellite
0245Z IR only	0000Z IR and VIS
0545Z IR only	0300Z IR only
0845Z IR only	0600Z IR only
1915Z IR only	0900Z IR only
1045Z IR only	0930Z IR only
1145Z IR only	1000Z IR only
1445Z IR only	1200Z IR only
1515Z IR only	1500Z IR and VIS
1545Z IR only	1600Z IR and VIS
1745Z IR and VIS	1800Z IR and VIS
2045Z IR and VIS	2100Z IR and VIS
2145Z IR and VIS	2130 IR only
2345Z IR and VIS	2200 IR only

B. From August, 1976 to September 5, 1978

West Satellite	East Satellite
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1015Z IR only	0930Z IR only
1045Z IR only	1000Z IR only
1515Z IR only	1600Z IR and VIS
1545Z IR only	2130Z IR only
2145Z IR and VIS	2200Z IR only

The times shown in B above were selected to coincide with the two NESS "picture pair" operational cloud motion vector derivations runs, and to provide a daily sample of coincident visible and IR data. (The NESS cloud motion product is also archived, see Appendix II). To this base was added, as of September 6, 1978, three hourly coverage timed to coincide as nearly as possible with standard synoptic data times.

The Archived Sector is centered on the satellite sub-point in the East-West direction and usually will start at 50°N. The process by which this area is extracted involves the use of orbit and attitude information and the operational earth location software, the accuracy of which is about 10 km.

The IR data archived at a resolution of 8 km in both directions (every other sample along each scan is dropped). The IR samples are 8 bit binary values (called "counts"), packed one per 8-bit byte. The Visible data are samples and averaged from its original resolution of 1 km in both directions down to 8 km. The Visible samples are 6-bit counts packed right-justified into 8-bit bytes.

The IR data may be calibrated in terms of temperature. This is accomplished by a two-step process. The first step is a conversion from "raw" counts to "calibrated" counts done at Wallops Island prior to retransmission of the stretched-form data. This conversion is done according to a "lookup" table to compensate for an annual fluctuation in the sensor response. The second step is performed by the user, and is the conversion of calibrated counts (the IR data on the VISSR Archive Tapes are calibrated counts) to temperatures through use of the "lookup" table included as Appendix I. The accuracy of these temperatures is limited to 2°K to 4°K, generally nearer 2°K in the winter and nearer 4°K in the summer. During the eclipse periods, three weeks on either side of the equinoxes, an additional 4°K error occurs due to thermal fluctuations on board the satellite as it moved through the earth's shadow. Note that the errors mentioned do not include the effect of atmospheric attenuation, etc., but are only errors arising within the radiometer system itself, which was not designed for quantitative applications.

Earth-location of the data (Visible and Infrared) is possible using benchmark data provided with each archived sector. The benchmark data consist of line and sample number coordinates of data samples falling on 2½° increments of latitude and longitude. The interpolation required is described in Section 4 of the description of the Benchmark Table. Users may also compute their own earth-location from the satellite orbit and attitude information included in the data (from November 1, 1976 on) as described in Section 4.

2. Element Names and Definitions:

1. Tape Layout

Tapes provided will be 9-track, phase encoded, 1600 bpi unless otherwise requested. Each tape will contain a series of one or more picture files, each being a straight or selective copy of a specified archive sector.

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The tapes in the SSD Archive contain six full sectors preceded by a Directory File. A user requesting a straight complete copy of an archived tape will receive the Directory File as the first file on the tape.

The general layout of each tape is as follows:

Directory file (On complete only)

End-of-file

Picture file #1

End-of-file

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Picture file #n

End-of-file

Each Picture file consists of nominally 1373 records: a 320-byte Header Record, four 6720-byte records containing a 26,880-byte Benchmark Table, and 1368 Data records, each containing the data from one scan or line of the SM/GOES picture. The maximum number of Data Records is 1368, the full archive image contains a maximum of 1368 lines. A selective copy sector limited in north-south extent would contain fewer lines. The length of Data Records of a sector limited in east-west extent will be less than 1628 bytes. The Header Record of each picture file and the length of each. The length of the Data Record is constant within the Picture File.

In the event of a missing picture, the End-of-File for that picture will be present, but no Data Records for the missing picture will be present.

2. Directory Record Format

The Directory Record is the single record in the Directory File. It contains a two-byte integer Fortran array dimensioned (6,6), where: I is the Picture File Number (1-6).

Where:

- (I,1) = Year of Picture on File #I.
- (I,2) = Julian Day Number of Pictures on File #I.
- (I,3) = Hour of Pictures on File #I.
- (I,4) = Minutes of Picture on File #I.
- (I,5) = Seconds of Picture on File #I.
- (I,6) = Milliseconds of Picture on File #I.

If (I,1) through (I,6) equals zero, then there are no Data Records present in Picture File #I, but its End-of-File will be there to permit the positioning on the tape to a desired Picture File by counting the File Marks.

3. Header Record Format

Elements of the Header Record are either 2-byte (16-bit) or 4-byte (32-bit) integers. Except for the number of Data Records in the Picture File (bytes 313 to 316) and the number of bytes in each Data Record (bytes 317 to 320), the 4-byte integers are values multiplied by 100, and are intended to be used as floating point numbers (i.e., converted to floating point and divided by 100).

The Header Record bytes are to be interpreted as follows:

Byte #	Internal Format	Description
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1,2	2-byte integer	Year	Picture start time of time of first VISSR scan line of that picture
3,4	2-byte integer	Julian Day No.	
5,6	2-byte integer	Hour	
7,8	2-byte integer	Minutes	
9,10	2-byte integer	Seconds	
11,12	2-byte integer	Milliseconds	VISSR Data Base Picture start time or time of VISSR scan that is the northern limit of the VISSR Data Base Picture.
13,14	2-byte integer	Year	
15,16	2-byte integer	Julian Day No.	
17,18	2-byte integer	Hour	
19,20	2-byte integer	Minutes	
21,22	2-byte integer	Seconds	VISSR Data Base End time or time of the VISSR scan that is the Southern Limit of the VISSR Data Base Picture.
23,24	2-byte integer	Milliseconds	
25,26	2-byte integer	Year	
27,28	2-byte integer	Julian Day No.	
29,30	2-byte integer	Hour	
31,32	2-byte integer	Minutes	Parameters that determine where the VISSR Data Base extraction process begins; i.e., that I,J of the upper left corner.
33,34	2-byte integer	Seconds	
35,36	2-byte integer	Milliseconds	
37,38	2-byte integer	VISSR Data Base Starting Scan Line	Parameters that define the VISSR Data Base Sector
39,40	2-byte integer	VISSR Data Base Starting Sample	
41,42	2-byte integer	VISSR Data Base Ending Scan Line #	
43	4-byte integer	Center Latitude	Parameters that define the VISSR Data Base Sector
47	4-byte integer	Center Longitude	
51	4-byte integer	Northern Latitude Limit	
55	4-byte integer	Western Longitude Limit	
59	4-byte integer	Unused	Bit error rate is an indication of how noisy the data are.
63	4-byte integer	Unused	
67	4-byte integer	Unused	
71	4-byte integer	Unused	
75	4-byte integer	Average Bit Error Rate	
79	4-byte integer	Minimum Bit Error Rate	
83	4-byte integer	Maximum Bit Error Rate	
87,88	2-byte integer	# of single line dropouts	
89,90	2-byte integer	# of multi-line dropouts	
91,130	2-byte integer	List of up to 20 single line dropouts	
131,190	2-byte integer	Table of up to Ten Group Dropouts as follows: Word 1 - Last good scan line Word 2 - First good scan line Word 3 - # of scans dropped out	

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191,192	2-byte integer	Center Latitude Sample	
193,194	2-byte integer	Center Longitude Sample	
195,294	2-byte integer	VISSR ingest computer documentation	
295,296	2-byte integer	Spares	
297,300	2-byte integer	ASCII Code for Data Type (IRbb or VISb)	
301,312	2-byte integer	Spares	
313,316	4-byte integer	Number of Data Records in the Picture File (or scans in the Sector). Zero indicates a full copy of the Archive Data. Note that this is a true 32-bit integer, not a scaled floating point number.	
317,320	4-byte integer	Number of bytes in each Data Record (scan); this is a true 32-bit integer.	

Note: Missing data for two-byte Integer Variables will be indicated by -1. Missing data for four-byte Integer Variables will be indicated by 99999.

4. Benchmark Table

The Benchmark Table, written on tape as four 6720-byte records, consists of an array of 6720 4 byte Integers (a total of 26,880 bytes). The array is considered to be dimensioned as (42,40,4) where I and J are arbitrary indices for latitude and longitude, respectively:

- (I,J,1) represents latitude of a point in degrees x 10.
- (I,J,2) represents longitude of a point in degrees x 10.
- (I,J,3) represents sample # for that point x 10.
- (I,J,4) represents scan line # for that point x 10.

If (I,J,1) through (I,J,4) equals zero, there are no benchmarks for that point. This indicates that there are no data in the Picture File for the latitude and longitude indexed by the I,J (or that the latitude and longitude falls outside of the Picture File, which may be either a copy of the original archive image or a sector extracted from it).

To step through 2½° increments of longitude, step through the second subscript J. A value of 1 for J points to the Western-most longitude.

To step through 2½° increments of latitude, step through the first subscript I. A value of 1 for I points to the Northern-most latitude.

To use the Benchmark Record to locate data on the VISSR Archive Tape, apply the following formulas shown below. In the case of a sector extracted from a full image, the centering correction will have already been applied, and a value of zero should be used for CENTERING.

For Visible Data

$$VSCAN = 2 * BSCAN - SSCAN$$

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$$VSAMPLE = \frac{1}{2} [BSAMPLE + CENTERING - SSAMPLE]$$

For Infrared Data

$$VSCAN = BSCAN - SSCAN$$

$$VSAMPLE = \frac{1}{2} [BSAMPLE + CENTERING - SSAMPLE]$$

Where: VSCAN = Scan line # on VISSR Archive Tape
 BSCAN = Scan line # from Benchmark Record divided by 10.
 SSCAN = VISSR data-base starting scan line # from the header record - 1
 VSAMPLE = Sample # on VISSR Archive Tape.
 BSAMPLE = Sample # from Benchmark Record divided by 10.
 CENTERING = 38th two-byte integer location of the VISSR ingest computer documentation from the Header Record. Use zero if the formula is being applied to a sector.
 SSAMPLE = VISSR data-base starting sample # from the Header Record - 1.

To find point (VSCAN, VSAMPLE) on the VISSR Archive Tape, apply the following formulas:

$$NREC = VSCAN - 1$$

$$NBYTE = VSAMPLE + 129$$

Where:

NREC = # of data records to skip on the VISSR Archive Tape before encountering the record containing the point (VSCAN, VSAMPLE).
 NBYTE = Byte # within the record (NREC + 1) containing the point (VSCAN, VSAMPLE).

5. Data Record

Each data record contains the data from one scan, and consists of 129 bytes of documentation followed by up to 1499 bytes of data. Thus, the maximum length of a Data Record is 1628 bytes. A sector extracted from the original archive image, which is limited east and/or west, will be made up of shorter Data Records. The number and length of the Data Records in each Picture File appear in its Header Record.

The contents of the 129 documentation bytes are defined as follows:

Byte #	Description of Contents
1	Retrace - FE16 indicates scanner retrace.
2	Spacecraft name.
3	Unassigned
4	Frame code - FE16 indicates picture transmission.
5	Change code - FE16 indicates first line picture if frame code is FE16 or last line plus one of picture if frame code is 116.
6	Step Code - FE16 indicates normal line transmission; 116 indicates that this line is not to be used to expose film

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	and facsimile recorder, line is not to be incremented (stopped).
7	Line delay - this number (1-8) denotes the delay to be introduced by the user, expressed in bit intervals.
8	IR selection - IRI - 00000001 IR2 - 00000010 AUG - 00000100
9	Gray Scale Status - FE16 indicates gray scale information retransmission.
10	Direct Transmission Mode - FE16 indicates 28 Mb/Sec; 116 indicates 14 Mb/Sec.
11	2 most significant BCD value split into 2 characters/word.
12	2 least significant BCD characters.
13	Scan Mode - A 00000001 B 00000010 C 00000100 D 00001000 Beta Count - 24 bits
14	8 most significant bits
15	8 mid-bits
16	8 least significant bits.
17	GRID/NO GRID - 11, indicates no grid information. Sync Error - 15 minutes
18	8 most significant bits.
19	7 least significant bits (least significant bit always 0).
20	8 most significant bits.
21	5 least significant bits (3 least significant bits always 0)
22	Setup Error - FE16 indicates setup error.
23	Computer Error Messages (S/DB) - 16 bits, any combination. Transfer Reject Errors - Time Input (Least Significant Bits) - Execute Output - NESS Output - Spacecraft Output High Rate I/O Errors - NESS Transfer - Output Transfer - Input Transfer (Most significant Bits)
24	Interrupt Sequence Errors - NESS Output (Least Significant Bits) - 4x4 Output - Spacecraft Input - NESS Pre-Sync - 4x2 Output Miscellaneous Errors - Undefined - Magnetic Tape Output - Beta Output (Most Significant Bits)

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25	Unassigned
26	Unassigned Date/Time - BCD
27	Year - 2 most significant digits.
28	Year - 2 least significant digits.
29	Day of Year - 2 most significant digits.
30	Day of Year - 2 least significant digits.
31	Hour
32	Minute
33	Seconds
34	Millisecond x 10
35	Black Enable - FE16 indicates annotation transmission.
36	Mode C - Calibrate - FE16 indicates that C-CAL is not used; otherwise: V1 00000001 V2 00000010 V3 00000100 V4 00001000 V5 00010000 V6 00100000 V7 01000000 V8 10000000
37	Bit/Frame Sync Lock - 00000001 Bit Lock - 00000010 Frame Lock - 00000100 Bit Frequency Lock
38	Limited Scan Mode Indicator - FE16 indicates scan mode
39	Sample Control Mode (least significant bit) IR - 2PT IR - 1pt IR - EAT VISIBLE - 4PT VISIBLE - 1PT VISIBLE - EAT
40	Visible Channel Connection Code for each channel is as follows: 0 = Normal 1 = Patched input reset V1 (LSB), V2, V3, V4, V5, V6, V7, V8 (MSB)
41	Scan Direction - FE16 indicates normal North-South direction
42	Bi-Phase Modulation On/Off - FE16 indicates on.
43	Unassigned
44	PLL Error Light - FE16 indicated error condition.
45	Test Data - Normal 00000000 - Local 00000001 - Remote 00000010

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	- Comp. Gen. IR 00000100
46	Data Randomization - FE16 indicates on.
47	Sun Pulse Select - FE16 indicates digital; 116 indicates analog.
48	NESS Mode Set - 4x4 IR 00000001 - MAX SV 00000010 - 4x4 IR 00000100
49	Limited Scan Command Encoder Enable - FE16 indicates on.
50	Digital Sun Pulse - 8 bits
51	Bit Error Light - FE16 indicates on.
52	Mean IR Difference - 8 bits
53	RMS IR Difference - 8 bits
54	Correction Table I.D. - 2 bytes.
55	Format Unknown. Position within Raster Line of left horizon point- 12 bits
56	4 most significant (always 0)
57	8 least significant bits
58	4 most significant bits (always 0)
59	8 least significant bits
60	Unassigned. Computer states messages (NESS ingest)
61	3 most significant bits.
62	8 least significant bits.
63	Unassigned
64	Missed Correlation Indicator - 1 = M.C.; 0 = M.C.
65	Number of bit slip interrupts detected during.
66	Ingest of this scan line - 16 bits
67	Unassigned
68-79	Spares
80	Telemetry Code Word.
81-98	Telemetry
99-124	26 (8-bit) bytes of orbit and attitude (see note). Group # equals 0 = No data. Group # equals N = Bytes 99=124 contain information in Group N as defined on following tables where N = 1 through 4.

Note: These locations were zero-filled prior to 1 November 1976 when the orbit and attitude data were inserted.

3. **Start Date:** 19740627

4. **Stop Date:** 19810305

5. **Coverage:**

a. Southernmost Latitude: 25.0S

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- b. Northernmost Latitude: 50.0N
- c. Westernmost Longitude: -125.0W
- d. Easternmost Longitude: -65.0E

6. How to Order Data:

Ask NCDC's Climate Services about the cost of obtaining this data set.
 Phone: 828-271-4800
 FAX: 828-271-4876
 E-mail: NCDC.Orders@noaa.gov

7. Archiving Data Center:

Archive Branch
 National Climatic Data Center
 151 Patton Avenue
 Asheville, NC 28801

8. Technical Contact:

National Climatic Data Center
 151 Patton Avenue
 Asheville, NC 28801

9. Known Uncorrected Problems: None.

10. Quality Statement:

11. Essential Companion Datasets:

12. References:

**Appendix I
 Temperature Calibration Table**

The final temperature calibration table may be used to convert the 8-bit data-count values to temperature values.

The following FORTRAN logic may be used to compute the table which is a 256-word array of temperature values ($^{\circ}\text{K} \times 10$). The array is indexed by the value of the Infrared data sample.

```
DIMENSION KELVIN (256)
N = 3300
DO1 I = 1,176
  KELVIN (I) = N
  N = N - 5
1 CONTINUE
DO2 I = 177,256
  KELVIN (I) = N
  N = N - 10
2 CONTINUE
```

N is initialized at 3300, representing a temperature of 330.0 $^{\circ}\text{K}$ which corresponds to the lowest count value (0).

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An example of a FORTRAN statement using the table would be:

```
KTEM = KELVIN (IRVAL + 1)
where: KTEM: Temperature, °K x 10
      KELVIN: Temperature Table
      IRVAL: An IR data Value (0-255)
```

A printout of the table follows with temperature values in °K, °C, and °F for each possible IR data-count value.

Appendix II

Winds Archive

The winds archive consists of sets of cloud motion vectors derived operationally by NESS by manual and automated techniques. The techniques involved are described in NOAA Technical Memorandum NESS 64 Central Processing and Analysis of Geostationary Satellite Data (March 1975).

This data is archived from October, 1974 to the present (1978). On 18 November, 1974, the cloud motion derivation operation was expanded from once to twice daily. The times each are nominally 0930Z/1000Z and 2130Z/2200Z from the East Satellite and 1015Z/1045Z and 1515Z/1545Z from the West Satellite

The wind tapes are formatted as shown in the table below. Note that for each vector the pressure altitudes and temperature are also provided. About 750 vectors are derived daily per satellite.

Monthly Winds Archive Tape Format

One archive tape will contain one month's accumulation of both manual movie-loop and automated picture-pair derived wind vectors.

Files - 1 per tape
Records - as many as required
Record length - 6000 8 bit bytes (1500 32 bit words)
Vectors/Record - N vectors, where N = 1,200; if N is less than 200, record will be zero filled)
Vector Length - 15 elements
Element Length - 2 bytes or 16 bits/element (binary)
Trailer record - 200, zero element vectors
Recording mode - binary
Density - 800 bpi/1600 bpi
Tracks - 9 track

Vector Description by element:

Element No.	Description
1	Year e.g. 4 = 1974
2	Month e.g. 11 = November
3	Day of month
4	Hour e.g. 14 = 1400 GMT
5	Pressure in tens of mb. e.g. 55 = 550 mb.
6	Temperature in °K (whole degrees)
7	Latitude x 10 e.g. -788 = 78.8°S
8	Longitude °W x 10 e.g. 1903 = 169.7°E

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9	Direction in degrees
10	Speed in knots
11	Octant, standard global octant (N-00, 1, 2, 3), (s-5, 6, 7, 8)
12	Count*, 1-9999, unique for each vector on a given run
13	Source code 1 = Suitland, Md.
14	Height confidence factor, 0-9, low to high
15	Total confidence factor, 0-9, low to high

* Picture pair derived wind vectors will start with 501.